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EMPLOYMENT OF HEURISTICS IN FORE-CASTING

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By: I. Myuller

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Block	Italic	Transliteration	Block	Italic	Transliteration
А а	*А а*	A, a	Р р	*Р р*	R, r
Б б	*Б б*	B, b	С с	*С с*	S, s
В в	*В в*	V, v	Т т	*Т т*	T, t
Г г	*Г г*	G, g	У у	*У у*	U, u
Д д	*Д д*	D, d	Ф ф	*Ф ф*	F, f
Е е	*Е е*	Ye, ye; E, e*	Х х	*Х х*	Kh, kh
Ж ж	*Ж ж*	Zh, zh	Ц ц	*Ц ц*	Ts, ts
З з	*З з*	Z, z	Ч ч	*Ч ч*	Ch, ch
И и	*И и*	I, i	Ш ш	*Ш ш*	Sh, sh
Й й	*Й й*	Y, y	Щ щ	*Щ щ*	Shch, shch
К к	*К к*	K, k	Ъ ъ	*Ъ ъ*	"
Л л	*Л л*	L, l	Ы ы	*Ы ы*	Y, y
М м	*М м*	M, m	Ь ь	*Ь ь*	'
Н н	*Н н*	N, n	Э э	*Э э*	E, e
О о	*О о*	O, o	Ю ю	*Ю ю*	Yu, yu
П п	*П п*	P, p	Я я	*Я я*	Ya, ya

*ye initially, after vowels, and after ъ, ь; e elsewhere. When written as ë in Russian, transliterate as yë or ë. The use of diacritical marks is preferred, but such marks may be omitted when expediency dictates.

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GRAPHICS DISCLAIMER

All figures, graphics, tables, equations, etc. merged into this translation were extracted from the best quality copy available.

RUSSIAN AND ENGLISH TRIGONOMETRIC FUNCTIONS

Russian	English
sin	sin
cos	cos
tg	tan
ctg	cot
sec	sec
cosec	csc
sh	sinh
ch	cosh
th	tanh
cth	coth
sch	sech
csch	csch
arc sin	$\sin^{-1}$
arc cos	$\cos^{-1}$
arc tg	$\tan^{-1}$
arc ctg	$\cot^{-1}$
arc sec	$\sec^{-1}$
arc cosec	$\csc^{-1}$
arc sh	$\sinh^{-1}$
arc ch	$\cosh^{-1}$
arc th	$\tanh^{-1}$
arc cth	$\coth^{-1}$
arc sch	sech^{-1}
arc csch	csch^{-1}

---

rot	curl
lg	log

EMPLOYMENT OF HEURISTICS IN FORECASTING

I. Myuller

Recently, forecasting has become, from one aspect, an increasingly important element in planning and control in science and technology — from another aspect, requirements are changing, requirements which must be satisfied by forecasts. The task has been posed to increase the national economic significance of forecasts, a task which has made them complex, has increased lead time, and has reduced the time from when the forecast was formulated until the time it is employed in planning. All this attests to the necessity for a transition from random developments, from utilization of independent or private forecasting methods to the creation and implementation of a forecasting method system. The requirement for such a system is determined by the following:

- In proportion to the increased complexity of the forecast and lead time, reliability of the formulations can be guaranteed only through the systematic application of a scientifically based forecasting system;

- Collectivity of work is possible only under the condition that the work is conducted according to a unified system;

- In compiling long-term forecasts, it is necessary to synthesize results obtained by means of individual methods.

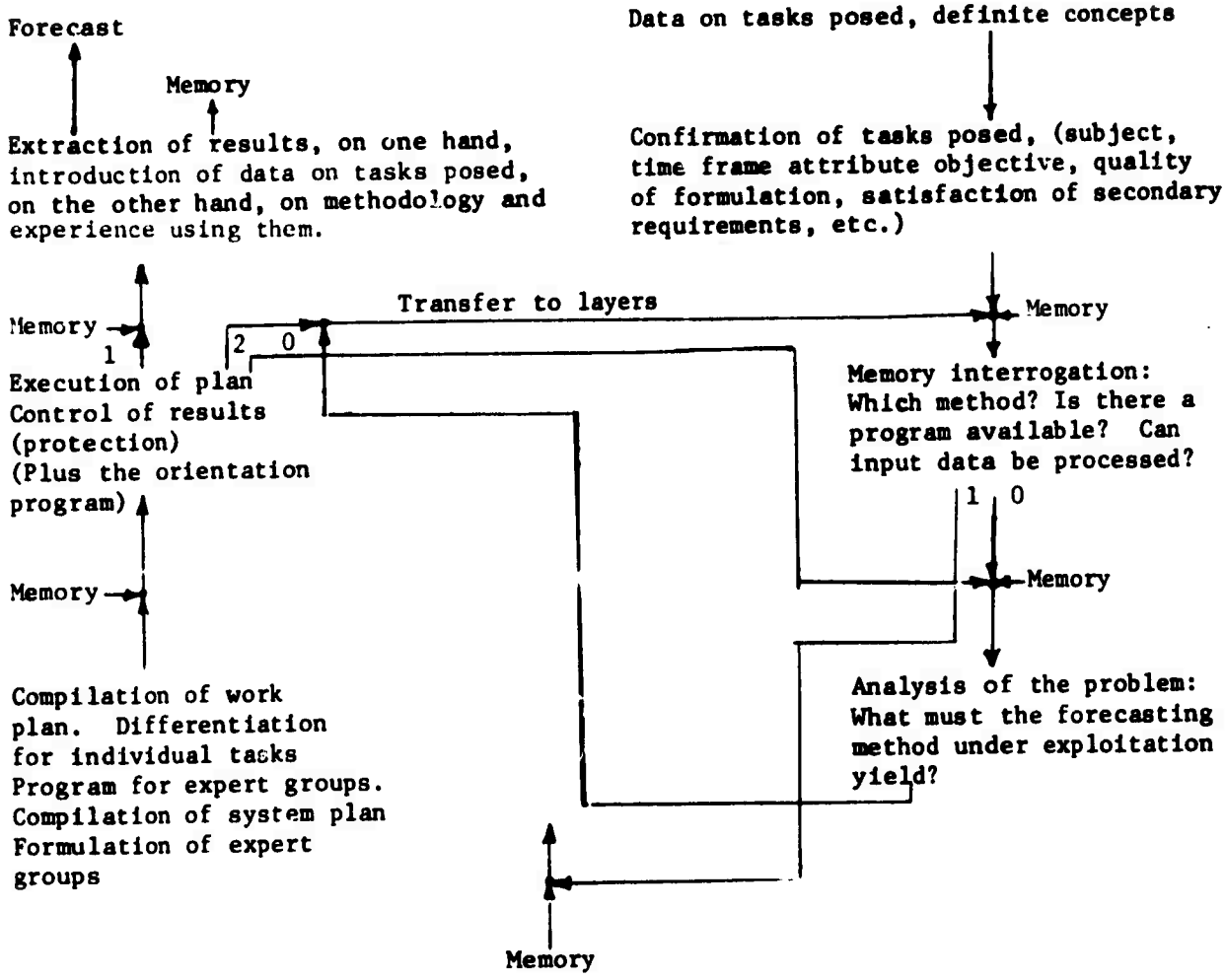
It is necessary in principle to go beyond the methods comprising extrapolation of simple trends and the establishment of expert evaluations. The resolution of the assigned task, in our opinion, is facilitated by systematic heuristics.

The goal of systematic heuristics is the researching of developmental phases in the solution of a problem in order to establish rules based upon that phase, the application of which enables optimum decisions to be made. As is known, the utilization of a system of programs in industrial research for the purpose of optimizing control and direction increases the efficiency of mental work by approximately 50% and improves its quality.

An account is presented below of an experiment employing a program of systematic heuristics in forecasting for the purpose of making work on research and design more efficient. The work was conducted in accordance with the main program of systematic heuristics, specified in connection with the task of formulating a forecast (Diagram 1).

DIAGRAM 1.

Specified main program of systematic heuristics

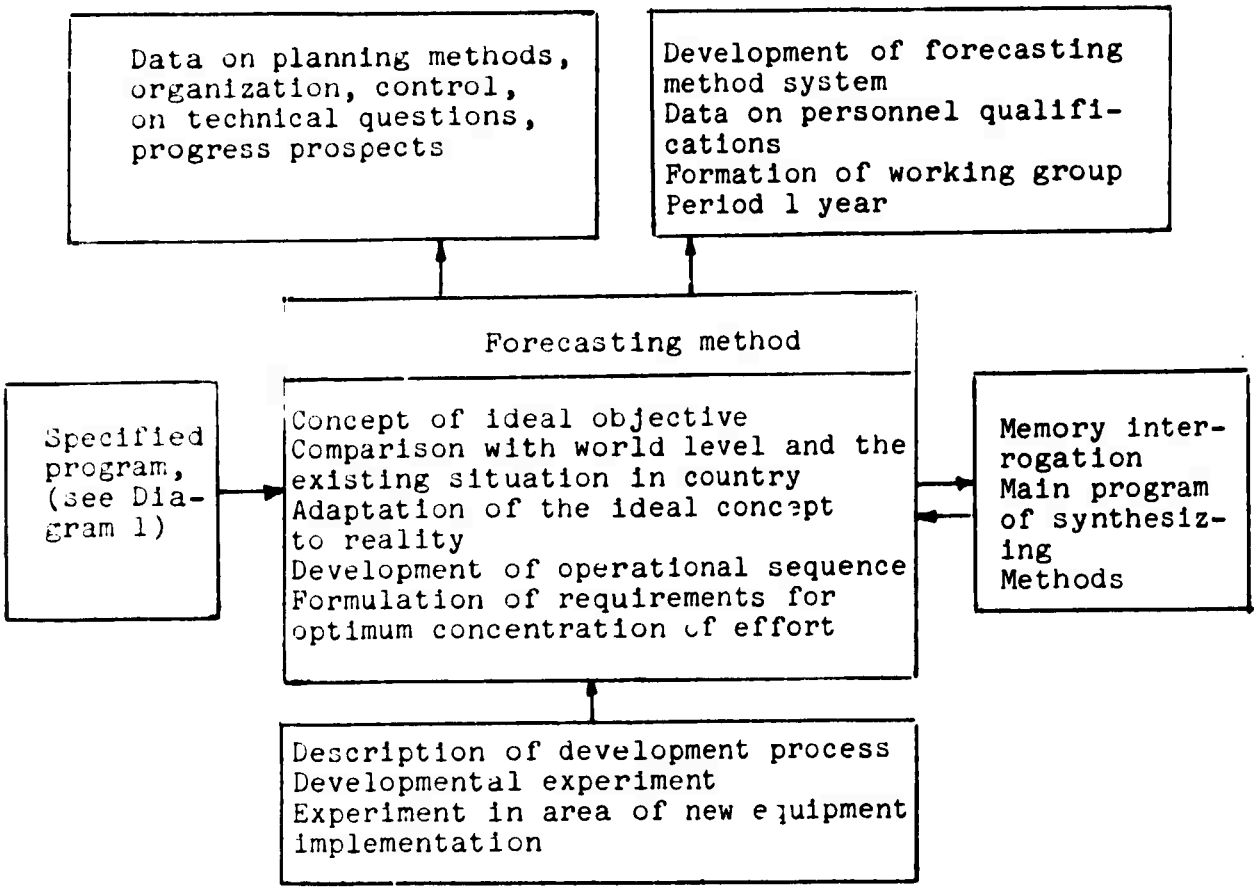


0. Insufficient result of operation
1. Result of operation may be considered sufficient and situated in the appropriate layer
2. Result recognized as sufficient, but is situated in the subadjacent layer

In accordance with this plan, an initiating committee was first organized, which undertook to specify those tasks posed and the development of a work plan for the central working group for the initial period of work. Specification of the tasks posed was effected by means of a special program. This process is presented schematically (Diagram 2).

DIAGRAM 2.

Specification of tasks and memory interrogation



The first phase of this process consisted of specifying the conditions for problem solution. This is linked with the fact, in our opinion, that widely-employed forms of forecasting work have, first of all, two shortcomings. On one hand, the tasks are advanced in the absence of a developed general concept of scientific forecasting. On the other hand, the significance of the stage for specification of posed tasks is underestimated and, as a result, the impression is often created that the forecasting groups are working without a clear concept of which tasks they are solving.

An analysis of the task set forth above indicates that, in the case cited, it was mandatory to establish the content and structure of the developmental system. Inasmuch as the developmental system

has changed little during the past 50 years, it was possible to evaluate the prospects for its development, based upon an extrapolation of current trends.

The basic problem consists of how to determine those process indices which are not yet manifested. Memory interrogation indicated that the forecasting methods widely used at present were unsuitable for this purpose. After this, proceeding from theoretical concepts, according to which development is an adaptive process of information processing, the conclusion was drawn that the development process could be conceptualized with the aid of a program employed in the development itself (Diagram 3).

DIAGRAM 3.

Cybernetic Modeling of System

Program prescribes the following phases:

1 1. Determine the system function, which is the forecasting objective, and classify the functional value flow!

↓

2. Determine basic operation in the function value flow!

↓

3. Determine the important system aspects for the function examined!

↓

4. Distribute systems to upper and lower, and determine the decision links between them!

↓

5. Describe the internal structure of the system and search for possibilities of optimization!

↓

6. Analyze function value flows and search for possibilities for their optimization!

↓

7. Check the system with respect to possibility of algorithmization of function value flow!

↓

(Diagram continued on following page)

DIAGRAM 3. (continued)

8. Check as to how controllability of the system can be improved, including utilizing game theory methods!

↓

9. Check as to whether all aspects of the system have been considered, and whether a combination of individual original diagrams can produce a new quality!

↓ I

10. Stop

After determination of the program element, it was found possible to develop a work plan, determine the functions of separate groups of specialists, and to compile a schedule. The plan was defended by the group studying basic questions of organization in the metal-working industry.

After the assigned stage was completed, conferences were held for members of the central group and groups of specialists. Our experience dictates that the next step is the detailed exchange of information. In this particular case, it was necessary that all members of the collective be equally well-informed about the problem. We did nothing that retarded the work. Another mistake often occurs; the work plan is compiled without a sound analysis of tasks proposed; this applies to the system schedule as well. Therefore, in the execution of the plan, results obtained were frequently found to be unsatisfactory and, as a result, the necessity arose for a repeat analysis employing new methods. A defense of the results in a special conference, for which the working group prepared a large number of questions, indicated that it was logical for this purpose to constitute a carefully selected collective and to develop a special methodology. We, particularly, found that the concise presentation of forecasting research conclusions was an entire problem in itself, inasmuch as one forecast often consisted of numerous pages itself. It was for this reason that those to whom it was addressed might not accept it for informational purposes.

Employment of the central working group's working plan indicated that utilizing systematic heuristics methods required the creation of a library for the necessary sub-programs. Above all, such sub-programs must be distributed in accordance with forecasting methods classification. It should be noted here that in the methodological plan, it is efficient to separate the programs into fields of forecasting; first of all, into determined and heuristic; secondly, into programs utilizing man or machine integrated automatic systems (this division corresponds to the criterion of equipment participation); and thirdly, into complex and elementary programs.

In the realization plan for the program forecasting approach, the programs might be divided into analytic-extrapolative, synthesizing, etc. Although a classification of programs based on purely forecasting criteria is preferable, a program classification based on methodological criteria might be useful, for example, in the development of memory in automated forecasting systems. In selecting a program, it is important to decide whether it is to be used as a main program or as a relatively elementary sub-program, because it is this decision which determines the procedure for memory interrogation. Because of this consideration in the resolution of problems in the field of development, it is advisable to employ the classification of forecasting methods, as shown in Diagram 4.

Results of the analysis of basic operations are presented in Diagram 5; the operations which were prepared by development. An analysis of the system for these operations indicated that primary possibilities for perfecting the system should be looked for in the rationalization of methodology structure, systems for planning, organization and direction.

Results of the indicated analysis are presented in the form of a staff-chart in Diagram 6. Such staff-charts are utilized for the analysis of information flows and their classification. Based on the classification, it was found possible to draw important conclusions on the structure of information systems, and particularly on

DIAGRAM 4.

Classification of objective elements and methods for forecasting their dynamics

Initial position in objective field	Methods	
	Analytic-extrapolative	Synthesizing
Defect or vacant space	Research on weak points, for example, market analysis demand, supply, or situation	Research of field of possibilities, for example, variants of use, structure, or function (including the methods DEL'FI — PERT)
Development pattern	Trend research (including regression and correlation methods)	System development (including methods for developing the "Law of Phenomena", utilization of the structures approach)

the optimum nature of memory structure, and also to formulate tasks for research in the cybernetics field. Additionally, a rigid requirement was established in the theory of adaptive systems. Besides this, conclusions were drawn on the possibility of creating algorithms, the demand for which will exist for some time. It became clear that in the future, the development process will include routine as well as creative elements, and that, in the future, we will find the employment of three classes of technical systems: computer equipment, man-machine systems, and integrated automatic systems.

DIAGRAM 5.

Basic elements of the development process

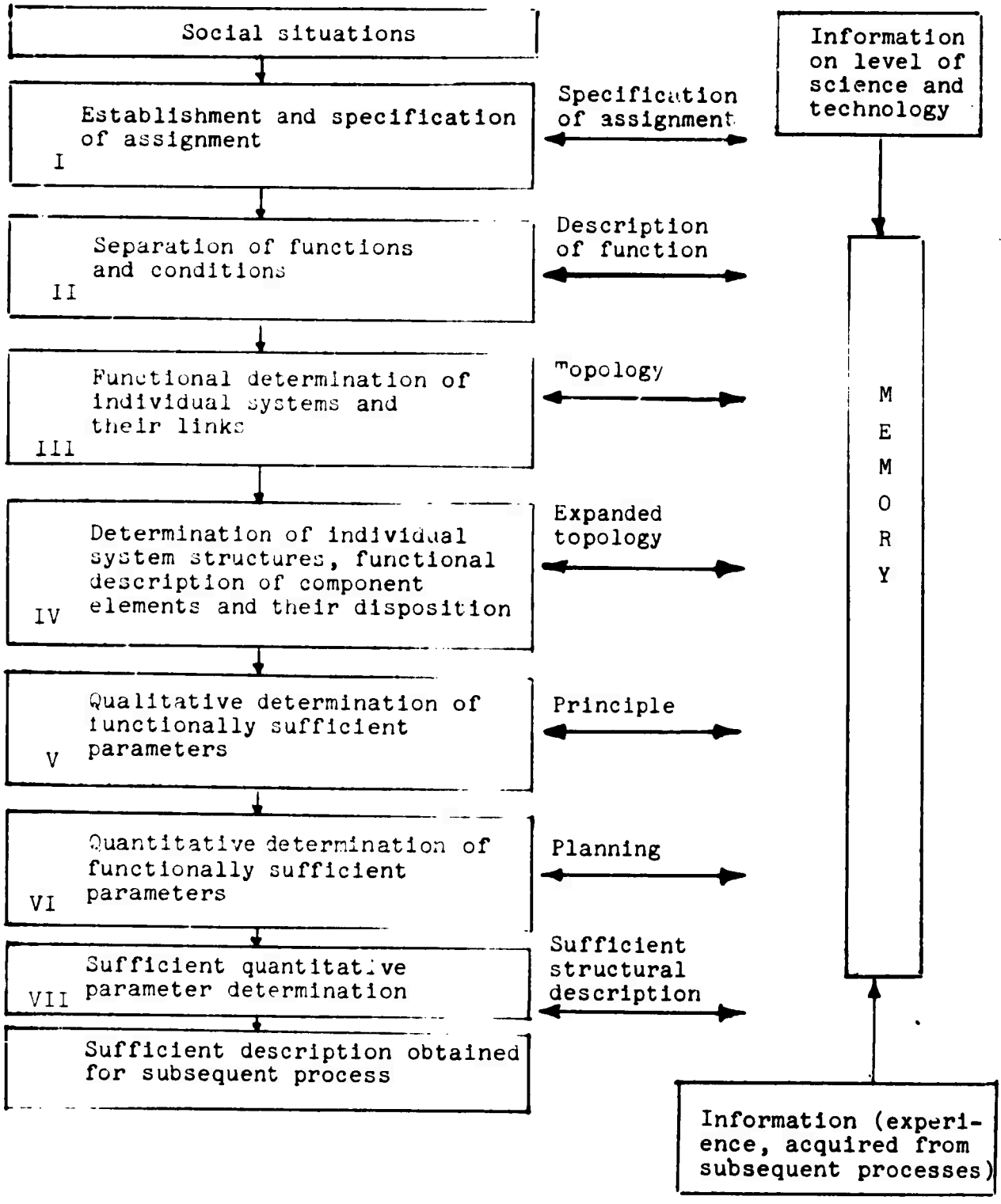


DIAGRAM 6.

Process classes in the system of developmental design processes

System class	Process class	Processing area
Major 1	Plan development	Association staff organization responsible for production of the specific article
Medium and minor 2	System development	Developmental situation
Units, components 3	Development of units (standard series)	Collective of institution responsible for development
Parts 4	Part development (standard series)	Collective (worker) in the institution

In perspective, the most widely-used system in the field of development will be the man-machine system. It follows from this that the creation of a universal machine language, the perfection of communication systems, and input and output devices, that engineering-psychological research will acquire primary importance in this respect.

It is also possible to make conclusions concerning actual research work in the field of theoretical adaptive systems, the psychology of modeling intellectual functions on computers, perfection of planning, organization, and direction. The existing achievements in these fields will find ever wider application.